(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 January 2002 (03.01.2002)

PCT

(10) International Publication Number
WO 02/01532 A1

(51) International Patent Classification[7]: G08G 1/0968, H04Q 7/20

(21) International Application Number: PCT/AU01/00758

"102e"

(22) International Filing Date: 26 June 2001 (26.06.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PQ 8381 26 June 2000 (26.06.2000) AU
PR 4793 4 May 2001 (04.05.2001) AU

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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR PROVIDING TRAFFIC AND RELATED INFORMATION

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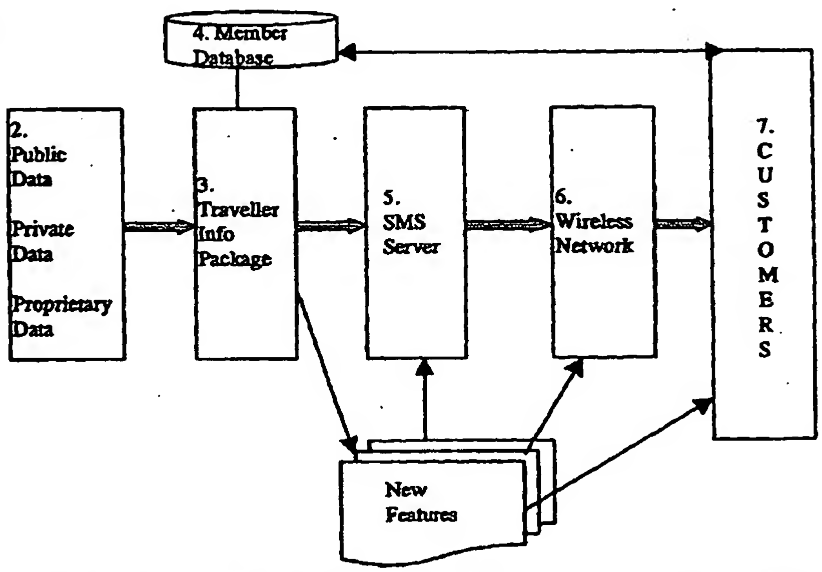

WO 02/01532 A1

(57) Abstract: The invention provides a system for providing traffic or related information including: a database storing historical traffic data being operable to receive substantially real time traffic data and associated data; means for integrating historical, real time and associated traffic data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and means for sending the customised forecasted traffic information to an intended recipient wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the traveller profiles.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method and system for providing traffic and related information

Field of the Invention

The present invention relates to traveller information services and in particular to a system for providing forecasted traffic information to individual travellers.

Background of the Invention

The monitoring and reporting of traffic conditions is an important factor in the management of traffic flow. From a motorist's point of view, it can be vital in saving commuting time and unnecessary delays. Substantial effort has been directed to providing facilities which allow a motorist or other user to access traffic and related information in a timely manner.

One type of known traffic reporting is by use of a "spotter", namely designated persons or members of the public who report traffic incidents to radio stations or a central controller, for subsequent dissemination to the public. Such a system however, cannot sustain the demand placed on it by today's user requirements.

More developed prior art systems include the use of sensors on roads, such as cameras that are linked to a central facility for the dissemination of traffic information. Sensors may be strategically located at exits/entrances to freeways and major roads. Other systems are cellular/mobile telephony based with sensors or designated spotters stationed on major roads and freeways. Such systems are integrated with a central control facility to provide cellular network subscribers with information regarding traffic flow, accidents, detours, road construction, etc. Subscribers may also have the opportunity to dial in and retrieve instantaneous information regarding a particular aspect of the traffic network such as a freeway.

The above-described systems, however, are limited in their capacity to provide useful customised information to subscribers. They are generally limited to providing the status of current traffic conditions supplemented by updated/incident reports that may give a clue to the duration of a problem. This does not satisfy the needs of the motorist who requires information relating to what the conditions will be at some time in the future when he

will be travelling past locations that are currently congested. Additionally, these systems do not provide an indication as to whether alternate routes are available and/or the details of those alternate routes.

A significant drawback of prior art systems is the lack of customised and critically timed information provided to individual subscribers.

It would therefore be desirable to provide a system for reporting traffic information to individual motorists in a timely and customised manner.

It would further be desirable to provide individual subscribers of a network with forecasted traffic information relevant to those individual subscribers.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention before the priority date of each claim of this application.

Summary of the Invention

The present invention provides a system for providing traffic or related information including:

a database storing historical traffic data being operable to receive substantially real time traffic data and associated data;

means for integrating historical, real time and associated traffic data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and

means for sending the customised forecasted traffic information to an intended recipient wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the traveller profiles.

In a preferred embodiment, the customised forecasted traffic information is transmitted to an information distributor who distributes the traveller information to users who have subscribed to the information distributor for the purpose of receiving traffic information relevant to their travel requirements. In this instance, it is preferred that subscribers have remote terminals in order to receive the customised information. The system

and the terminals may provide for communication from the subscriber to the system.

Historical and real time traffic data is likely to mostly comprise data collected from traffic control signals and traffic sensors and detectors placed at strategic locations throughout a traffic network. The database may be operable to store historical and real time traffic data and/or associated data for frequent retrieval. The historical traffic data stored in the database preferably includes a sample of previous traffic data relating to geographical areas of interest to subscribers. Such data may include data from strategically relevant locations such as traffic congestion areas, traffic flow at particular landmarks and speeds along specific routes. Associated data may include data collected from other sensors and detectors such as sensors for measuring and reporting temperature and rainfall and may also include data relating to significant events that may have an impact upon the flow of traffic through a traffic network. (eg holidays?)

Associated traffic data stored in the database preferably includes information on incidents, accidents, road construction, alternate routes and weather information. Associated data may be obtained from any print, electronic or radio communication which is then converted to data for storage in said database and subsequently used by the system.

The means for integrating historical, real time and associated traffic data may include a model that provides an indication of the expected delay for a particular link based upon historical records. Using a model as compared with referencing base data should reduce storage requirements and may also reduce computation time and hence provide more timely results.

By providing a system according to the present invention, a subscriber is able to receive traffic or related information with respect to his or her travelled route before and/or during the journey. The system may provide subscribers with updated and relevantly timed information which is forecasted with respect to a subscriber's customary travelling patterns.

The applicant has recognised that there is a "space-time window" in which a motorist requires personalised, customised and localised travel information and that information received before or after that "space-time window" period is of limited use to a traveller.

Of course, the system may include a database of information relating to subscribers and may supply customised forecasted traffic information directly to subscribers.

In an embodiment of the present invention there is provided a system for providing traffic and related information to subscriber terminals including:

a subscriber database;

a plurality of subscriber terminals in a network capable of receiving at least text messages;

a database storing historical traffic data being operable to receive substantially real time traffic data and associated data;

means for integrating said historical data and said real time data with respect to subscriber profiles stored in said subscriber database, to produce customised forecasted traffic information for individual subscribers; and

means for sending said customised forecasted traffic information to individual subscriber terminals in said network at times that are critical to individual subscribers wherein the customised forecasted traffic information includes a predicted travel delay for travel routes described in a subscriber's travel profile.

In a preferred form of the invention, the subscriber is a motorist and the network is a cellular or a mobile communications network. The network may support Short Message Service (SMS), Wireless Application Protocol (WAP) or third generation (3G) wireless broadband networks.

The subscriber database preferably stores individual subscriber profiles in a non-volatile memory with each individual subscriber profile preferably including information regarding the identity of the subscriber. Profiles may also include parameters such as usual travel times, the route usually taken and the times at which a subscriber would prefer to receive customised forcasted traffic information. These times may be considered critical by the individual subscriber. A subscriber may be provided with access to a database to alter the parameters of their profile. The access may be provided via a dedicated web-site.

Subscriber terminals may include a mobile communication device capable of receiving traffic information and/or other related information. The device may be a mobile telephone forming part of a mobile communications

network and may be adapted to receive data in SMS, WAP or 3G formats. The device may even incorporate text to voice or IVR techniques.

Preferably, the device is able to request information from the database regarding historical or real time traffic information.

The means for integrating historical and real time data may include a model of the expected delays for various traffic links based upon historical data. In this instance, the model preferably includes an adaptive mathematical model for forecasting traffic information. The model may also compare the historical data variables with real time data in accordance with a subscribers travel route. Statistical techniques may be employed to determine the effects of the data variables and may include multi-variate regression, multi-variate time series, spectral analysis piece-wise daily templates or the like, or any combination thereof. In addition to expected delays resulting from traffic density, incidents may occur that could significantly increase the historically expected delays. The occurrence of an incident that may have a significant effect upon the forecasted delay to a subscriber may be sent to a subscriber prior to his or her next major route change thus enabling the subscriber to perhaps select an alternate route in an attempt to avoid any increase to the subscriber's expected travel time.

In a particularly preferred embodiment, the system includes a means for determining an optimal path of travel through a travel network. The means for determining the optimal path of travel through the network may employ a method that takes account of the direction of traffic flow on each individual travel link in the traffic network. Additionally, it is preferred that the method also take account of the different delays caused by traffic signals to individual traffic flows through a signal controlled intersection.

In some instances, there may only be limited historical traffic data available for any particular traffic network or part thereof. In addition, real time traffic signal data may only be available for a limited number of signal controlled intersections of the traffic network at a frequency sufficient to be relevant for the purpose of predicting travel time. In this instance, the means for determining the optimal travel path through a traffic network preferably implements a method of matching data received from the limited number of signal controlled intersections with remaining intersections in the traffic network for which there is no timely available traffic signal data.

Similarly, in the instance where a system is intended to be used for a traffic network where there is limited available traffic data, or perhaps no traffic data is available, the system may include a means for determining an estimate of the travel flows wherein the means implements a method of matching signal controlled intersections from a traffic network with known data to the traffic network with limited traffic data. This enables the system to at least establish a first estimate that may be refined over time as more traffic data for that network becomes available.

In a preferred embodiment, the matching of data from traffic controlled intersections throughout a traffic network takes account of various factors including the geometry of the intersection, the orientation of the intersection and the ratio of actual flow of traffic resulting from a particular traffic signal as compared with the maximum flow of traffic possible for that same signal. This latter factor is referred to as the "degree of saturation"(DOS). Of course, the method of matching intersections throughout a traffic network may include additional factors such as historical daily averages for signal cycle times for the intersections. The various factors used to determine a match between intersections may be given a priority or weighting in order to establish an order of importance for each factor. This order, or weighting, of individual factors may vary when matching intersections with known data of a traffic network to those of another traffic network such as in those other cities. In addition, the order, or weighting, of individual factors may vary from one region of a traffic network to another.

The means for periodically sending customised traffic information may include at least one database server capable of sending at least text messages. The customised traffic information is preferably forwarded to a mobile network of the subscriber. The frequency and time of the information being formulated and dispatched may be determined by the subscriber's travel profile. The information may be sent before and/or during a subscriber's travel route.

In an alternative form, the forecasted information may be customised according to the location of the subscriber. The location or position of the subscriber may be determined by positioning systems such as Global Positioning System (GPS), Mobile Positioning System (MPS) or other means.

According to another aspect, the present invention provides a method of providing traffic or related information including the steps of:

a) storing historical, real time and associated traffic data in a database;

b) integrating said historical, real time and associated data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and

c) sending the customised forecasted traffic information to an intended recipient wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the traveller profiles.

In an embodimnent, the present invention provides a method of providing traffic or related information including the steps of:

a) storing historical, real time and associated traffic data in a database;

b) integrating said historical, real time and associated data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and

c) sending the customised forecasted traffic information to subscriber terminals that are capable of receiving at least text messages in a network and at times that are critical to subscribers wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the subscriber's profile.

In a particularly preferred embodiment, the method includes the step of determining an optimal path of travel through a travel network which preferably takes account of the direction of traffic flow on each individual travel link in the network. Additionally, it is preferred that the method also take account of the different delays caused by traffic signals to individual traffic flows through a signal controlled intersection.

In some instances, there may only be limited historical traffic data available for any particular traffic network or part thereof. Additionally, real time traffic signal data may only be available for a limited number of signal controlled intersections of the traffic network at a frequency sufficient for that data to be relevant for the purpose of predicting travel time. In this instance, the means for determining the optimal path through the traffic network preferably implements a method of matching data received from the limited

number of signal controlled intersections to remaining intersections in the traffic network for which there is no timely available traffic signal data.

Similarly, in the instance where a method is intended to be used for a traffic network where there is limited available traffic data, or perhaps no traffic data is available, the method may include the step of matching signal controlled intersections from a traffic network with known data to the traffic network with limited traffic data.

In a preferred embodiment, the method of matching data from traffic controlled intersections throughout a traffic network takes account of various factors including the geometry of the intersection, the orientation of the intersection and the ratio of actual flow of traffic resulting from a particular traffic signal as compared with the maximum flow of traffic possible for that same signal (i.e. the DOS). Of course, the method of matching intersections throughout a traffic network may include additional factors such as historical daily averages for signal cycle times for the intersections. The various factors used to determine a match between intersections may be given a priority or weighting in order to establish an order of importance of each factor. This order, or weighting, of individual factors may vary when matching intersections with known data to those of another traffic network such as those in other cities. In addition, the order, or weighting, of individual factors may vary from one region of a traffic network to another.

Brief Description of the Drawings

The following description refers in more detail to the various features of the traffic information system of the present invention. To facilitate an understanding of the invention, reference is made in the description to the accompanying drawings where the traffic information system is illustrated in a preferred embodiment. It is to be understood that the traffic information system of the present invention is not limited to the preferred embodiment as illustrated in the drawings. In the drawings:

Figure 1 is a schematic diagram of an embodiment of a traffic information system in accordance with the present invention;

Figure 2 is a flow diagram illustrating an embodiment of the traffic forecasting process in accordance with the present invention;

Figure 3 is a diagrammatic representation of a typical traffic intersection identifying travel links and individual traffic flows;

Figure 4 is a diagrammatic representation of a typical relationship between vehicle flow and vehicle concentration for a typical traffic link;

Figure 5 is a diagrammatic representation of typical relationships between vehicle flow rate and vehicle concentration for various different classes of roads; and

Figure 6 is a diagrammatic representation of the relationship between mean free vehicle speed and degree of saturation as derived in an embodiment of the invention,

Detailed Description of a preferred embodiment of the Invention

A preferred embodiment of the invention is described below with reference to the accompany Figures 1 to 6.

Real Time Traffic Related Data

Referring now to Figure 1, there is shown a schematic diagram of one embodiment of a traffic information system 1 of the present invention. In the instance of the preferred embodiment, the system includes the means for sending customised traffic information directly to travellers who have subscribed to receive such information. Of course, the system could provide the customised information to a third party information distributor who in turn effects the distribution of the customised information to individual subscribers.

The system of Figure 1 includes various sources 2 for providing real time traffic related data and associated data. These sources 2 may include publicly available data, private data or proprietary data. A database 3 stores historical traffic data. The database 3 interfaces with sources 2 to receive real time traffic data and associated data. The database 3 also includes means for integrating historical, real time and associated traffic data including means to perform a statistical analysis of the data, and is adapted to produce customised traveller information packages.

A member or subscriber database 4 stores travel profiles for individual subscribers which are consulted when producing traveller information packages for individual subscribers 7. An SMS server 5 provides a gateway between the database 3 and a wireless network 6, such as a mobile or GSM network.

The subscriber 7 has mobile communications means, such as a mobile phone which is operable to receive data transmitted via the mobile network 6. In the preferred embodiment, customised text messages are received on the subscriber's phone regarding relevant traffic information according to the subscriber's travel profile. The subscriber 7 may be provided with access to his profile stored in the subscriber database 4, via the Internet or other access means. This provides the subscriber 7 with the opportunity to edit and alter his travel profile.

The various sources 2 of data generally provide real time traffic related data. Such sources can include highway loop detectors, video cameras, publicly and privately owned sources, and vehicles fitted with GPS devices having radio or mobile communication devices for transmitting data relating to the progress of the vehicle through the traffic network. Additionally, air surveillance may be used as well as general media reports.

The interface between the database 3 and the sources 2 of data include automatically collected public information from various web sites such as weather forecasts and other visual and voice information which are received and keyed in by operators to add to the automatically collected information.

<u>Integrating Historical, Real Time and Associated Traffic Data</u>

The database 3 incorporates software to integrate and process historical traffic data and any real time data with respect to a subscriber's travel profile. Numerous techniques are available for such processing. The software in the preferred embodiment is written in Perl and in one embodiment, the software operates on a PC using the Linux operating system.

Referring to Table 1, there is shown an example of the type of information stored in the database 3.

No.	Suburb	Depart	Entry	Entry Time	Exit	Exit Time	Destn
1341	Box Hill	6.30	MDL	7.05	HOD	7.20	BMDS
1342	Donvale	6.40	SPR	6.47	HOD	7.20	SUN
1343	N. Balwyn	6.40	BUL	6.50	HOD	7.10	CBD
1345	Kew	6.40	BRK	6.50	HOD	7.20	CAR
1345	S. Wantirna	6.45	SPR	7.00	HOD	7.30	CBD
1346	S. Wantirna	6.45	SPR	7.00	HOD	7.30	CBD

1347	Wheelers Hill	6.50	WEL	6.55	PNT	7.35	BMDS
1348	Wheelers Hill	6.50	SPR	6.55	HOD	7.50	BMDS
1349	E. Doncaster	6.50	DON	7.00	HOD	7.30	ABB
1350	Balwyn	7.00	CHN	7.10	HOD	7.30	BMDS
1351	Glen Waverley	7.00	BILK	7.10	HOD	7.45	CBD
1352	Rowville	7.00	WEL	7.10	PNT	8.00	BIRD
1353	Rowville	7.00	WEL	7.10	PNT	8.10	BMDS
1354	E. Doncaster	7.00	BILK	7.12	HOD	8.00	BMDS
1355	Rowville	7.00	WEL	7.15	PNT	8.20	CBD
1356	Greensborough	7.00	BRK	7.20	HOD	7.50	CBD

Table 1

In this instance, real time data has been integrated with historical data to produce predicted travel times for given routes. The example relates to travel from outer suburbs to the Monash freeway in Melbourne, Victoria. By way of illustration, the entry number 1345 will be considered as an example. The information contained in this entry enables the system to predict that departing South Wantirna at 6.45am will mean entry onto the freeway at around 7.00am via the Springvale entrance. Exit at Hoddle St is forecasted to be at 7.30am. The information contained in the database 3 may be continually updated.

Referring again to Figure 1, the SMS server 5 receives customised messages from the database 3 in the form of e-mails. The e-mails contain the customised forecasted traffic information for the individual subscribers 7. The forecasted travel time information, incidents and weather information is delivered via the SMS server 5 over the mobile network 6 to the mobile phones of the subscribers 7. The forecasted information can be delivered during various time windows such as the night before, just prior to commencement of the journey, en-route or just before bifurcation point offering the choice of alternative routes to the destination. Subscriber profiles contained in the subscriber database 4 determine the frequency and time of the forecasted information being delivered.

Table 2 illustrates a snapshot of customised messages generated and delivered to individual subscribers.

23/11/99 07:16:01: establish ppp link
23/11/99 07:16:03: sending Sathish, APPROX 22 mins TO PNT to 0414123456@trial.epus.com.au
23/11/99 07:16:04: sent 1 mail messages
23/11/99 07:21:07: sending Grant, APPROX 16 mins TO HOD to 0414234567@smsa.erics.com.au
23/11/99 07:25:30: Processing Eastern + Freeway
23/11/99 07:25:31: Processing Monash + Freeway
23/11/99 07:25:31: Processing West + Gate + Freeway
23/11/99 07:26:12: sending Tracey, APPROX 13 mins TO HOD to 04191234561@cfsms@ericn.com.au
23/11/99 07:31:17: sending Michael, SPR -> HOD 19 mins to 0415987654@semes.epa.com.au
23/11/99 07:31:19: sent 3 mail messages
23/11/99 07:36:23: sending George, JAC -> PNT 28 mins to 0419123456@xyz.epanyb.com.au
23/11/99 07:41:28: sending Geoff, APPROX 15 mins TO HOD to 0414333444@abc.eric.com.au
23/11/99 07:41:38: sent 2 mail messages

Table 2

For example, the message sent to Sathish at 7.16am forecasts that it will take him 22 minutes to reach Punt Rd. Similarly, for Grant, the message at 7.21am forecasts that it will take him 16 minutes to reach Hoddle St. Typically these messages are sent to the subscribers prior to the commencement of their journey.

For example, the subscriber who leaves home from Rowville at 8.00am and enters the Monash freeway at Wellington Rd at approximately 8.15am would get a standard forecasted traffic information message at 7.55am. If an incident occurs between 7.55am and 8.15am, a further message is sent via the mobile phone to that subscriber before he enters the freeway. In this way, the subscriber is informed at critical times of the traffic situation on his route of travel thus enabling subscriber to alter their normal travel route in an attempt to avoid delays caused by the incident.

Further down the table, there are three entries which show the processing of traffic information on the freeways. This illustrates the operation of integrating real time data with historical data to provide forecasted information. The processing is conducted periodically or when updated real time data is received in the database.

Referring to Figure 2, there is shown a process flow diagram of one example of the traffic forecasting process employing statistical modelling. The process flow includes the following steps:

Step 1: Obtain an accumulated series of historical data which could be in the form of continuous 2-10 minute averages of delay in various geographical locations thus forming a series of historial dealys in time steps.

Step 2: Using conventional spectral methods, seasonal trends in the historical data are obtained and removed from the historical data and the result output and tabled as Traffic data.

Step 3: Obtain historical weather data and splice it with the remaining unaltered traffic data so that for each entry in the traffic data table, columns of a) Days since last rain (D_r); and b) Rainfall in last 3 hours (R) are added. Then add columns to the previously output traffic data table to indicate whether the data is in some or all of:

i) School holiday period (S_h = 0 or 1)
ii) Common summer holiday period (C_h = 0 or 1)
iii) Weekend/weekday (W_e = 1/0)
iv) Public Holiday or day before/after (P_h, P_h^-, P_h^+)

The above variables are examples of associated traffic data that relates to the types of events that can be modelled into the process and similarly, other variables may be entered as well. By adding the additional columns described, the effect of weather patterns relating to the various events and certain time periods are added to the Traffic data table.

To generate a model of the historical data suitable for predictive analysis, the traffic data is divided into seven files corresponding to each day of the week. The data in each file is combined by averaging which represents 15 minute or 30 minute averages depending on what frequency is required. Typically, 30 minute periods will be sufficient. So in operation, for example, consider the average delay at 8:30am on a Monday morning. The representative delay data for a particular or given route of travel comprises

the individual delays for the intersections and/or freeways, referred to as links, on that route at the expected commencement time for each link of the route. The average delay for each link for the 30 minute period between 8.30am to 9.OOam, is obtained from a time average of two minute intervals over the 30 minute period. The sample interval of two minutes is a continuous stream of data obtained from sensors or the like at freeways, intersections, etc. The interval period may be varied depending on the frequency that is required.

All such average delay data gathered for 8:30am on a Monday morning, are grouped into a separate file and a least squares fit of the data is performed using the function:

$$\begin{aligned} \text{Delay} = \; & a_0+a_1*D_r/(a_2+D_r)+a_3*R/(a_4+R)+a_5*S_h+ \\ & a_6*C_h+a_7*W_e+a_8*P_h+a_9*P_h^-+a_{10}*P_h^+ \end{aligned}$$

where:

D_r : Days since last rain
R : Rainfall in last three hours
S_h : School holiday period
C_h : Common summer holiday period
W_e: Weekend/weekday
P_h: Public holiday
P_h^- : Day before public holiday
P_h^+ : Day after public holiday

In the preferred embodiment, the above modelling is performed for each 30 minute period of each day for seven days. This generates 336 sets of the 10 coefficients (a_0 to a_9) which describe the historical data for each link. Whilst not necessary, the use of a model to describe the historical data should result in a reduced primary and secondary storage requirement as compared with storing all the available averaged historical data in RAM. Where a model is used, it is expected that the model would be regenerated every six months or so. In the instance of the preferred embodiment, the least squares fit analysis would be executed every six months to generate a new 336 sets of the coefficients (a_0 to a_9) for each link.

Step 4: Obtain real time data from various sources relating to measured link delays of the network and associated data relating to the actual weather conditions for the links in the network.

Step 5: For each link in the network, determine the historically expected delay based upon the seasonally adjusted historical delay and the measured weather conditions and compute for each link the ratio of the most recently measured delay for the link to the historically expected delay for the link at a time step corresponding to the measured delay. This ratio is labelled "JVL".

Step 6: When predicting the expected delay from a commencement node to a destination node, determine the historically expected delay for each link as it would be at the expected commencement time for each link and multiply the historically expected delay for each link of the route by the link's corresponding JVL ratio prior to summing the historically expected delays on each of the links to thus form a predicted expected delay for travel from the commencement node to the destination node.

Incidents that affect the expected travel delay on a traffic link in a network are entered manually into a database by an operator. Due to the wildly varying nature of incidents, the expected delay that will occur to traffic on an affected link is necessarily reliant upon the estimation of a human observer. The observations of incident observers and the expected link delays resulting from incidents are entered into a database that the integrating means accesses on a regular basis to update the database of historically expected link delays. In another embodiment, the expected delays to traffic links caused by incidents may remain in a separate database as compared with the database of historically expected link dealys and the two databases may be accessed at the time of providing a predicted actual delay for a traveller travelling from a commencement node to a detination node in the network. Over time, as further observations are received regarding

incidents, the incident database may be updated to reflect any change in the expected delay caused by the incident.

In the preferred embodiment, the incident database is accessed every time a traveller profile causes the prediction and transmission of the travel delay for the subscriber.

Optimal Path Through Traffic Network

In a preferred embodiment of the invention, the customised forecasted traffic information system includes the determination of an optimal path through the traffic network for the subscriber to reach his or her destination in the least time. The search for the optimal path through a traffic network takes account of each link flow direction and the various different delays caused by traffic control signals to traffic movement through each intersection as well as operator input and other automatic data feeds.

With reference to Figure 3, a diagrammatic representation of a traffic intersection 11 is provided with incoming/outgoing links connecting it to intersections (nodes) 12, 13, 14 and 15. The links may be bi-directional and there may be more nodes connected to node 11 than detailed in Figure 3. In general, traffic arriving at B (or the queue terminating at B) will take different times to move through the intersection to C, D or E. These times will be dependent upon the congestion on each of the links and the traffic signal settings at intersection 11.

For the purposes of this specification, the term "degree of saturation" (DOS) is used to refer to the ratio of the actual flow of traffic movement resulting from a particular traffic signal as compared with the maximum possible flow of traffic resulting from that signal. DOS is a measure of the intersection congestion and may, under some circumstances, be transformed to a delay in seconds for the particular movement.

For the purposes of this specification, the term "mean free travel time" is used to refer to the travel time down a link when all traffic control devices are removed.

With reference to Figure 4, a typical relationship between vehicle flow and vehicle concentration is detailed for a typical traffic link. As will be noted from Figure 4, the relationship is a convex curve intersecting the vehicle concentration axis at a vehicle concentration and saturation of zero. A value for the "mean free speed" for the traffic link may be determined from

Figure 4 by dividing the vehicle flow (expressed as vehicles per second) by the corresponding concentration (expressed as vehicles per metre). As it will be recognised by those skilled in the art, the "mean free speed" is a difficult quantity to determine.

In a preferred embodiment of the invention, the mean free vehicle speed down each link of a carriageway is obtained from the relationship between vehicle flow rate and vehicle concentration for various different classes of roads (e.g. freeways, arterials, suburban streets). Figure 4 also details the point at which saturation flow on a traffic link occurs (x_m, f_m).

Typical relationships are detailed in Figure 5 for different classes of roads. It is also preferable to determine a further relationship between vehicle concentration and degree of saturation. Since the DOS is directly proportional to vehicle flow, the vehicle flow may be deduced from the DOS. For vehicle flows less than the saturation flow on a link (ie less than f_m in Figure 4), the mean free speed may be calculated by dividing the flow (deduced from the DOS) by the corresponding concentration. For vehicle flows greater than the saturation flow, corresponding to higher DOS, the vehicles experience a rapid decrease in mean free speed to close to zero. The relationship between mean free speed and DOS is shown in Figure 6. The actual relationship beyond the Degree of Saturation corresponding to saturation flow may be obtained from experiment. Accordingly, the DOS can be used to estimate a flow rate which can be divided by the vehicle concentration to provide the mean free speed.

A model of travel time from A to B to C to F is to sum the un-congested travel times from A to B and C to F with the delay in the movement B to C. The un-congested travel times are the mean free travel times. These times can be calculated from mean free travel speeds, which are generally constant for all roads of a particular type, and the link length. Computationally, it is convenient to define a link travel time as the mean free travel time plus the time to negotiate the immediate upstream intersection. That is, the travel time on link BCF is the mean free travel time on link CF plus the time to negotiate the movement BC. The latter may be computed from quantities transmitted by the traffic control system at regular time intervals (eg 1 minute). For example, in the SCATS (Sydney Co-ordinated Adaptive Traffic System) traffic control system, the variables needed for the calculation of intersection movement delays are:

- Date/Time
- Intersection Strategic Approach number (e.g. a link number)
- Regional Computer name/number (the identity of the computer providing data)
- Sub System number
- Green signal time for the strategic approach
- Signal cycle time for the strategic approach
- DOS for the strategic approach

Defining link travel times as described above means that traditional optimal path searching methods, for example Dijkstra, may be used. However, it also means that there are several travel times associated with each particular link. For example, the travel times associated with each link comprise the times for intersection movements BC, EC, DC and CFC (a U turn) added to the mean free travel time down link CF, that is, four link travel times.

Generally, if there are n links joined at a node, there are n*n travel times associated with that node. When conducting a search from a given node for the next node in the optimal path, the upstream node on the path to the current node needs to be known, in order that the correct link travel time to the new node can be computed.

In the preferred embodiment of the invention, for each different time of day at which an optimal search is conducted, the link travel times are stored in a single continuous vector. Another vector includes indices of the first vector where information about the delays through a particular node can be found.

For example, suppose NCOST is a vector of travel times and NINDEX(nn) is the index of intersection nn at which link travel times start in NCOST. If there are k links joining at intersection nn, then the link travel times for links joining node nn occupy positions NINDEX(nn) to NINDEX(nn)+ k*k - 1 in vector NCOST. Specifically, if i = (NINDEX(nn)+ j*k - 1 + n) with j<k and n <= k, then NCOST(i) is the delay between node nn and the j'th downstream node given that traffic entered node nn from upstream node n. This approach is a relatively efficient method of storing link delays which is updated easily as new intersection delays become available.

It is only necessary to store single connections between nodes since the travel time on CF given that arrival at node 1 was via AB occupies a different position in the vector NCOST than the travel time on BA given that arrival at node 1 was via FC. Bi-directional flow is handled in this way.

In practice, NCOST may be two dimensional, the first dimension referring to the time of day and the second referring to link delays as described above. For example, if the system is running on 10 minute average data from traffic control signals, the first dimension will be 144, as there are 144 separate 10 minute periods in a day.

Traffic incidents like road-works, temporary/permanent road closures and accidents can be handled in the above scheme by entering a very large link travel time in the appropriate position of NCOST for the known or estimated time of the incident. In the case of uni-directional links, a very large link delay may be entered permanently in the position of NCOST which relates to the illegal movement direction.

Most incidents will be handled by an operator typing codes relating to the incidents into a file. The computer program will read the file regularly (eg, every 5 seconds) and update NCOST. If an incident has occurred and the delays on appropriate links have been set to large values, the data coming from the traffic control system can be compared with historical data for the part of the network affected by the incident. As the incident is cleared, the dynamic data will return to "normal" and the large link delays can also be returned to normal values. The dynamic data thus provides a feedback path to the incident detecting operator.

Historical data from the traffic signals should be collected so that there exists a complete 24 hour typical data set for each day of the week. Before collecting this data, the minimum sampling period should be determined (eg 10 minutes). At the start of a given day, the relevant data set should be loaded into NCOST.

As each day progresses, the system should collect the current signal data, process it in a form suitable to fill the relevant time slot of NCOST and archive it for off-line modification of the historical database.

When a request for an optimal or fixed trip time is received, the link delays collected from the last few periods of traffic signal data may be compared with the corresponding historical data, and estimates may be made

of each element of complete vectors of NCOST for the following n time steps using various methods including:

- Time series analyses
- Exponential weighting
- Direct multiplication of the historical values by the ratio of the currently available delay to the historical delay for each link delay.

Incidents are added and removed if necessary by an operator dynamically. Incident reports may be received by voice and the essential information extracted electronically using voice recognition techniques and transferred to the database of incident reports.

The preferred embodiment of the invention recognises that at the time a trip starts, the link delays part way through the trip are not the delays at that same start time. As the search method proceeds, the elapsed time to each node in the trip is computed and the vector of NCOST appropriate for that particular time is used when computing the next link delay in the trip. Clearly, in the absence or failure of a dynamic data feed, historical data can be used, but as dynamic data becomes available, it can be used to modify the succeeding vectors of historical data in NCOST to reflect current traffic conditions. From the known origin and destination of the trip, an approximate estimate of the trip travel time can be made using pessimistic mean travel speeds appropriate to the time of day. This is then used to estimate the number of time periods in NCOST over which a prediction must be made.

Although the preferred embodiment has been described in relation to the SCATS system, it is conceivable that the present invention may be readily adapted to receive and utilise data that is collected by alternative traffic control systems such as the SCOOT (Split Cycle Offset Optimisation Technique) system.

Predicting Traffic Network Movement Delays

Some traffic control systems are unable to provide a completely updated set of movement delays at each intersection in less than one hour. However, they can update perhaps ten per cent of the intersections of the traffic network in less than ten minutes. By carefully choosing the

intersections from which to collect traffic data, this data may be matched to the remaining intersections for which timely data is not available.

The intersections chosen for data collection must cover the geometry and capacity range of the intersections for which timely data is not available. One measure of capacity is average DOS over a day. Historical data allows collection of appropriate data and calculation of this quantity for all intersections. Any two prospective matches should have similar DOS. Similarly, if historical green signal times and signal cycle times are available, daily averages of these can also be used for matching pairs of intersections.

Any two matched intersections preferably have the same number of intersecting links. For data matching purposes, the orientation of intersections are preferably arranged such that the links closest to pointing to the Central Business District are aligned. In addition, both intersections should preferably be as close as possible to being the same distance from the Central Business District.

All of the above matching criteria are available "off line". That is, they can be applied to the system if only the network geometry and appropriate historical data are known. The more matching factors that can be applied, the more accurate the match between the intersections will be. In the preferred embodiment, the criteria of matching numbers of links, distance from the Central Business District and orientations with respect to the Central Business District are always used. Once matches are determined, collected intersection data may be exported to matching intersections, providing a full set of traffic data for an entire network.

With respect to the matching process, it is interesting to note that errors in link delays tend to cancel out over trips that traverse a large number of links.

If traffic data is available for a portion of one city but none is available for another city that has similar traffic flow characteristics to the first, intersection matching using some of the attributes discussed above can be performed to estimate the traffic data in the city for which no traffic data exists. Local knowledge in the city to be matched may allow classification of the intersections by "busyness" which may be equated to ranges of the average daily DOS values for the intersections in the city where data has already been collected. It is then possible to estimate travel times throughout the day in the new city. This approach allows a travel time advisory system to be

established in any city for which traffic characteristics are known to be similar to those in a city already operating such a facility. Over time, appropriate data may be collected in the "new" city to improve the historical database. Ideally, this historical data needs to be supplemented with dynamic data from floating or seeded vehicles in order to be able to provide genuine real time traveller information. In any event, applying a traffic data matching process at least enables a first estimate to be established for a city with no actual available traffic data.

Alternative Means for the Delivery of Traffic Information

Alternative means for delivering the messages may include text to voice conversion. The forecasted traffic information can be converted into speech and transmitted either as a voice call or if not answered, then left as a voice message for subsequent retrieval. In another form, traffic information from the database can also be made available through a menu based interactive voice response (IVR) system. Furthermore, HTML text can be truncated to more basic WML text suitable for display on WAP and/or 3G mobile phones.

Referring again to Figure 1, in an alternative arrangement, positional data for individual subscribers 7 can be determined and related to the server 5. A GPS, MPS or other suitable positioning system can be employed to determine the exact position and status of an individual subscriber. If the subscriber alters his travel departure time, his customised messages can be dynamically updated based on his current status as determined by his positional data. Subscribers can also request specific information as required. The service invoked in an SMS protocol is known as "push" and "pull" messages. A push/pull service is where an SMS message is sent from a subscriber's phone requesting traffic information (a pull) and an SMS message is sent (a push) in return with the required information. Subscribers may also access a dedicated web-site which has information for the general public as well as specific access for the subscribers. The subscribers can alter their profiles as they desire. The types of information contained within a subscriber profile may include the subscriber's expected time of departure, primary and alternate routes with which the subscriber is familiar and the subscriber's preference for weather forecast information.

Conclusion

The method and system of the present invention embodies many advantages and it will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A system for providing traffic or related information including:

a database storing historical traffic data being operable to receive substantially real time traffic data and associated data;

means for integrating the historical and real time traffic and associated data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and

means for sending the customised forecasted traffic information to an intended recipient wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the traveller profiles.

2. A system according to claim 1 wherein the intended recipient receives the customised forecasted traffic information for all traveller profiles and separates the information relating to each traveller profile for subsequent transmission to individual travellers according to their profile.

3. A system according to either claim 1 or claim 2 wherein at least one individual traveller, having a traveller profile, has a remote terminal operable to receive transmitted customised forecasted traffic information.

4. A system according to claim 3 wherein the remote terminal is operable to transmit information to the database.

5. A system according to claim 3 or claim 4 wherein the remote terminal is a mobile phone.

6. A system according to any one of the preceding claims wherein customised forecasted traffic information is transmitted to a traveller prior to the commencement of a traveller's journey.

7. A system according to any one of the preceding claims wherein customised forecasted traffic information is transmitted to a traveller during the traveller's journey.

8. A system according to any one of the preceding claims including a traveller database for storing individual traveller profiles, the traveller profiles including data identifying the traveller and data relating to the traveller's usual travel routes and usual time of commencement on those routes.

9. A system according to any one of the preceding claims wherein the traveller's profile indicates the times that the traveller prefers to receive customised forecasted traffic information.

10. A system according to either claim 8 or claim 9 wherein individual travellers are provided access to the traveller database and may alter data contained in the database relating to their profile.

11. A system according to any one of the preceding claims wherein the means for integrating historical, real time and associated traffic data is operable to:

a) determine a time series of average delays from historical data for links in a traffic network the time series extending over a pre-determined period of time;
b) receive historical weather data and correlate that weather data with the historical traffic data and generating an average historical delay for the links during various weather conditions;
c) receive real time data relating to weather in the geographic region of the traffic network;
d) estimate the actual link delays that will occur on each of the traffic links for each of the time series based upon the received data; and
e) generate a prediction of the actual delay from a commencement node to a destination node of the traffic network by summing the respective link delays of the links along the travel route using the estimate for each link delay at the time the traveller is expected to commence travel along those links.

12. A system according to claim 11 wherein the integrating means determines seasonal trends in the historical traffic data relating to average link delays and removes those seasonal trends from the historical traffic data.

13. A system according to either claim 11 or claim 12 wherein the integrating means estimates the actual traffic link delay that will occur for a link some time in the future by receiving real time traffic data relating to measured delays on traffic links and calculating the ratio of the most recently measured traffic link delay to the average historical link delay for the corresponding time step at which the measurement was taken and multiplying the average historical link delay for the link at a future time step with the previously established ratio thus generating an estimate of the actual link delay that will occur for the link at the time step in the future.

14. A system according to claim 13 wherein the integrating means generates an estimate of the actual traffic link delay that will occur for a link some time in the future for all traffic links of the network relevant to traveller profiles.

15. A system according to any one of claims 11 to 14 wherein the integrating means determines predictions of actual delay that will occur for travel routes according to traveller profiles at the times required by each respective traveller profile.

16. A system according to any one of claims 11 to 15 wherein the integrating means receives data relating to events such as school holiday periods, summer holiday periods, public holidays and weekends and correlate that data with the historical traffic data.

17. A system according to any one of claims 11 to 16 wherein the integrating means includes a model of that data generated by performing a least squares fit analysis to determine an average historical traffic delay using the function:

$$\begin{aligned} \text{Delay} = \; & a_0 + a_1 * Dr / (a_2 + Dr) + a_3 * R / (a_4 + R) \\ & + a_5 * Sh + a_6 * Ch + a_7 * We + a_8 * Ph + a_9 * Ph^- \\ & + a_{10} * Ph^+ \end{aligned}$$

Where Dr represents period since last rain
R represents rainfall in last predetermined period
Sh represents school holiday period
Ch represents common summer holiday period
We represents a weekend or weekday
Ph represents a public holiday
Ph^- represents a day before a public holiday
Ph^+ represents a day after a public holiday

18. A system according to any one of claims 11 to 17 wherein estimates of link delays caused by incidents are received and stored for subsequent access by the integrating means for summing with the historically expected link delays when predicted travel delays are generated.

19. A system according to any one of the preceding claims including a means for determining an optimal path of travel through a traffic network, the means being:

a) operable to determine a link travel time for each traffic link in a network; and
b) operable to implement a path searching method to determine the optimal path between two nodes in the traffic network, the optimal path being the series of connected traffic links between the two nodes resulting in the least expected delay.

20. A system according to claim 19 wherein the determination of a link travel time for a traffic link in a network is obtained by summing the mean free travel time for that link and the average time required to negotiate the immediate upstream intersection connected to that link.

21. A system according to claim 20 wherein for traffic links with vehicle flow rates less than the saturation flow rate, the mean free travel speed is obtained by dividing the vehicle flow rate for that link by the vehicle concentration for that link, and the mean free travel time is obtained by dividing the distance of the link by the mean free travel speed.

22. A system according to any one of claims 20 or 21 wherein the average time to negotiate an immediate upstream intersection is obtained from the traffic network's traffic control system.

23. A system according to any one of claims 19 to 22 wherein upon receiving a request to provide an optimal travel path through a traffic network, measured link delays most recently collected from traffic signal data are compared with historical link delay data and an estimate of the actual link delay data is generated for each traffic link in the network for an appropriate number of steps in the time series according to the traveller's commencement and destination nodes in the network.

24. A system according to claim 23 where, in the event that real time link delay data for a traffic link is not available, historical link delay data is used.

25. A system according to any one of the preceding claims where there is insufficient historical traffic data for links in a traffic network to generate historical link delay data, the means for integrating historical and real time data uses available traffic data for other links in the same and/or different network as estimates for those various links for which there is no data available.

26. A system according to claim 25 wherein the traffic links for which no traffic data is available are matched to other traffic links for which traffic data is available, the matching process taking account of one or more of the following:

a) the relative geometry of the traffic links;
b) the relative arrangement of the traffic links;
c) the relative capacity of the traffic links;
d) the relative alignment of the traffic links with locations of relatively high population density;
e) the relative DOS of the traffic links;
f) the relative distance of the traffic links from locations of relatively high population density.

27. A method of providing traffic or related information including the steps of:

a) storing historical, real time and associated traffic data in a database;

b) integrating said historical, real time and associated data with respect to traveller profiles to produce customised forecasted traffic information with respect to those traveller profiles; and

c) sending the customised forecasted traffic information to an intended recipient wherein the customised forecasted traffic information includes predicted travel delays for travel routes described in the traveller profiles.

28. A method according to claim 28 including the step of the intended recipient receiving the customised forecasted traffic information for all traveller profiles and separating the information relating to each traveller profile and transmitting the relevant traffic information to each individual traveller according to their profile.

29. A method according to either claim 27 or claim 28 including the step of an individual traveller, having a traveller profile and a remote terminal, receiving customised forecasted traffic information on that terminal.

30. A method according to claim 29 wherein the remote terminal is operable to transmit information to the database, the method including the step of an individual traveller transmitting information to the database.

31. A method according to any one of claims 27 to 30 including the step of determining from the traveller profiles the travellers usual travel routes and usual commencement time on those routes.

32. A method according to any one of claims 27 to 31 including the step of determining from the traveller's profile the times that travellers prefer to receive customised forecasted traffic information.

33. A method according to claim 32 including the step of sending customised forecasted traffic information to a traveller in accordance with the

preferred times for receiving the information as determined from the traveller's profile.

34. A method according to either claim 32 or claim 33 including the step of a traveller accessing their stored travel profile and altering the data contained in that profile.

35. A method according to any one of claims 27 to 34 wherein the step of integrating historical, real time and associated data with respect to traveller's profiles to produce customised forecasted traffic information includes the steps of:

a) determining a time series of average delays from historical data for links in a traffic network, the time series extending over a predetermined period of time;
b) receiving historical weather data and correlating that weather data with the historical traffic data and generating an average historical delay for the links during various weather conditions;
c) receiving real time data relating to weather in the geographic region of the traffic network;
d) estimating the actual link delays that will occur on each of the traffic links for each of the time series based upon the received data; and
e) generating a prediction of the actual delay from a commencement node to a destination node of the traffic network by summing the respective link delays of the links along the travel route using the estimate for each link delay at the time the traveller is expected to commence travel along those links.

36. A method according to claim 35 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of determining seasonal trends in the historical data relating to average link delays and removing those seasonal trends from the historical traffic data.

37. A method according to either claim 35 or claim 36 wherein the step of integrating historical, real time and associated data with respect to traveller

profiles includes the step of estimating the actual traffic link delay that will occur for a link some time in the future by receiving real time traffic data relating to measured delays on traffic links and calculating the ratio of the most recently measured traffic link delay to the average historical link delay for the corresponding time step at which the measurement was taken and multiplying the average historical link delay for the link at a future time step with the previously established ratio thus generating an estimate of the actual link delay that will occur for the link at the time step in the future.

38. A method according to claim 37 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of generating an estimate of the actual traffic link delay that will occur for a link some time in the future for all traffic links of the network relevant to traveller profiles.

39. A method according to any one of claims 35 to 38 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of determining predictions of actual delays that will occur for travel routes according to traveller profiles at the times required by each respective traveller profile.

40. A method according to any one of claims 35 to 39 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of receiving data relating to events such as school holiday periods, summer holiday periods, public holidays and weekends and correlating that data with the historical traffic data.

41. A method according to any one of claims 35 to 40 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of modelling the historical and real time data by performing a least squares fit analysis to determine an average historical delay using the function:

$$\begin{aligned}\text{Delay} = \;& a_0 + a_1 * Dr / (a_2 + Dr) + a_3 * R / (a_4 + R) \\ & + a_5 * Sh + a_6 * Ch + a_7 * We + a_8 * Ph + a_9 * Ph^- \\ & + a_{10} * Ph^+\end{aligned}$$

Where Dr represents period since last rain
R represents rainfall in last predetermined period
Sh represents school holiday period
Ch represents common summer holiday period
We represents a weekend or weekday
Ph represents a public holiday
Ph^- represents a day before a public holiday
Ph^+ represents a day after a public holiday

42. A method according to any one of claims 35 to 41 wherein the step of integrating historical, real time and associated data with respect to traveller profiles includes the step of receiving data relating to estimated link delays caused by incidents and storing that data for subsequent access whereby estimated delays caused by incidents are summed with historically expected link delays when predicted travel delays are generated.

43. A method according to any one of claims 35 to 42 including the step of identifying an optimal path of travel through a traffic network by determining a link travel time for each traffic link in a network and implementing a path searching method to determine the optimal path between two nodes in the traffic network, the optimal path being the series of connected traffic links between the two nodes resulting in the least expected delay.

44. A method according to claim 33 wherein the step of determining link travel time for a traffic link in a network includes the step of summing the mean free travel time for that link and the average time required to negotiate the immediate upstream intersection connected to that link.

45. A method according to claim 44 wherein the determination of the mean free travel time for a traffic link includes the step of obtaining the mean free travel speed by dividing the vehicle flow rate for the link by the vehicle concentration for that the link and obtaining the mean free travel time by dividing the distance of the link by the mean free travel speed.

46. A method according to either claim 44 or claim 45 including the step of obtaining an average time to negotiate an immediate upstream intersection from the traffic network traffic control system.

47. A method according to any one of claims 43 to 46 including the step of identifying a request to provide an optimal travel path through a travel network and upon receipt of such a request, comparing measured link delays most recently collected from traffic signal data with historical link delay data and estimating the actual link delay for each traffic link in the network for an appropriate number of steps in the time series according the traveller's commencement and destination nodes in the network.

48. A method according to claim 47 including the step of identifying whether sufficient recent real time link delay data for a traffic link is available according to a pre-established criteria and in the event that sufficiently recent link time delay data is not available, making use of historical link delay data.

49. A method according to any one of claims 35 to 48 including the step of identifying whether there is insufficient historical traffic data for links in a traffic network to generate historical link delay data in accordance with a pre-established criteria and in the event of identifying that insufficient data exists, using available traffic data for other links in the same and/or different networks as estimates for those various links for which there is no available data.

50. A method according to claims 49 wherein the step of using available traffic data for other links in the same and/or different network as estimates for the various links for which there is no available data includes the step of matching the traffic links for which no traffic data is available to other traffic links for which traffic data is available, the method step taking account of one or more of the following;

a) the relevant geometry of the traffic links;
b) the relative arrangement of the traffic links;
c) the relative capacity of the traffic links;
d) the relative alignment of the traffic links with locations of relatively high population density;

e) the relative DOS of the traffic links;

f) the relative distance of the traffic links from locations of relatively high population density.

51. A system according to claim 1 substantially as hereinbefore described with reference to the acompanying drawings.

52. A method according to claim 27 substantially as hereinbefore described with refernce to the accompanying drawings.

Dated this twenty-sixth day of June 2001

Custom Traffic Pty Ltd, Ros Trayford, Charles Karl
Patent Attorneys for the Applicant:

F B RICE & CO

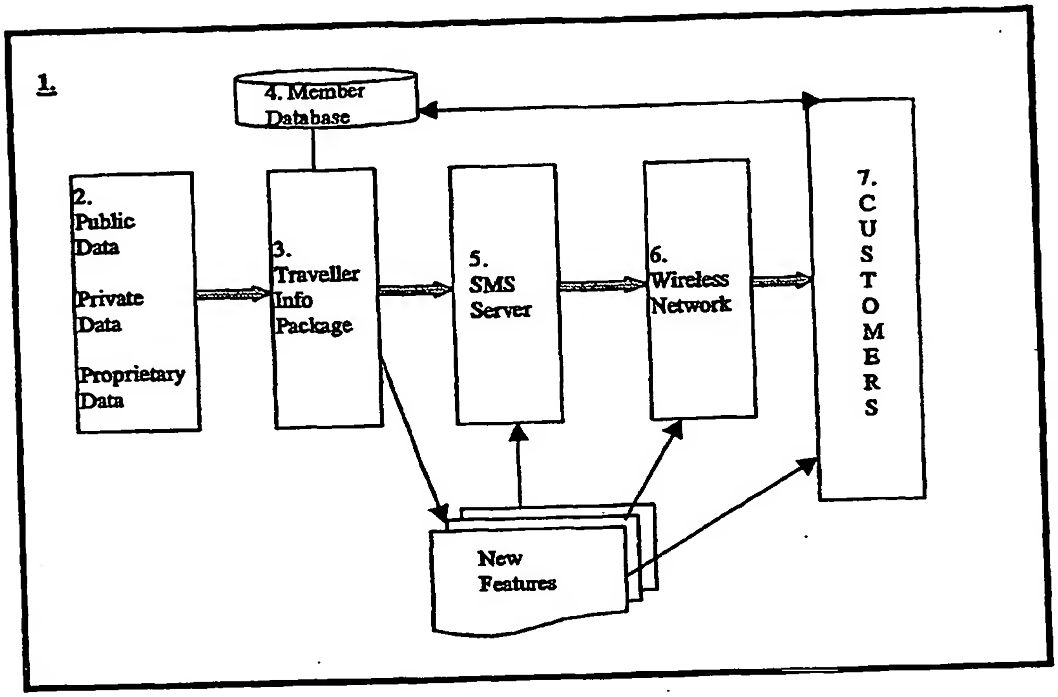
1.
4. Member Database
2. Public Data
Private Data
Proprietary Data
3. Traveller Info Package
5. SMS Server
6. Wireless Network
7. CUSTOMERS
New Features

Figure 1

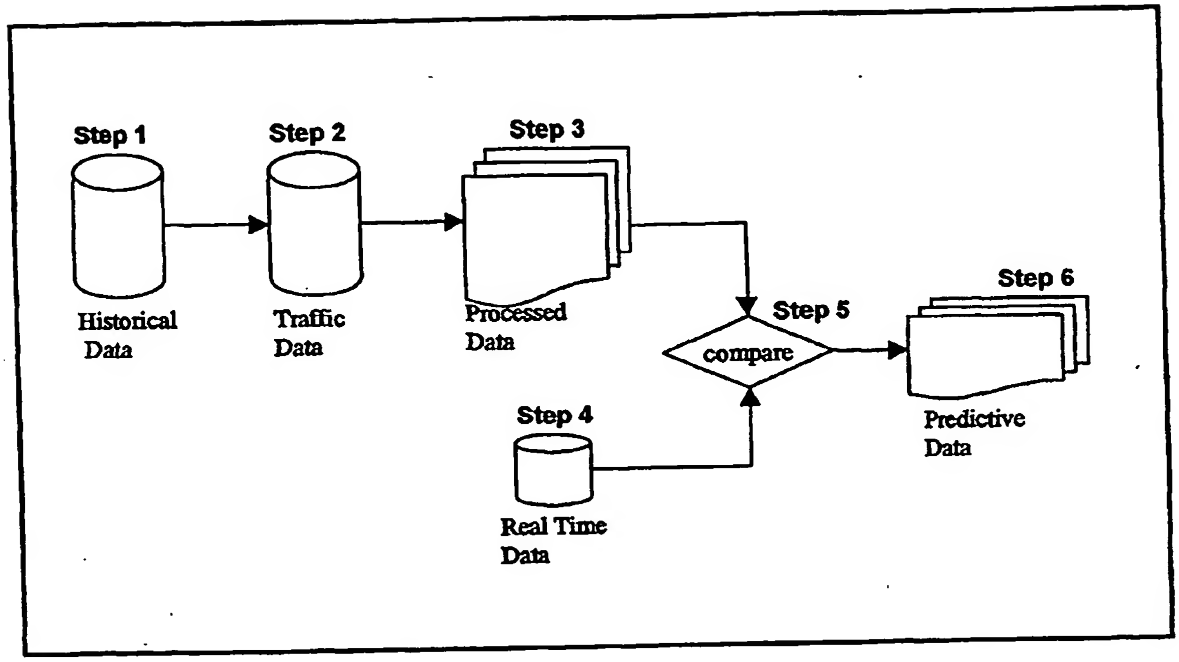
Step 1
Historical Data
Step 2
Traffic Data
Step 3
Processed Data
Step 4
Real Time Data
Step 5
compare
Step 6
Predictive Data

Figure 2

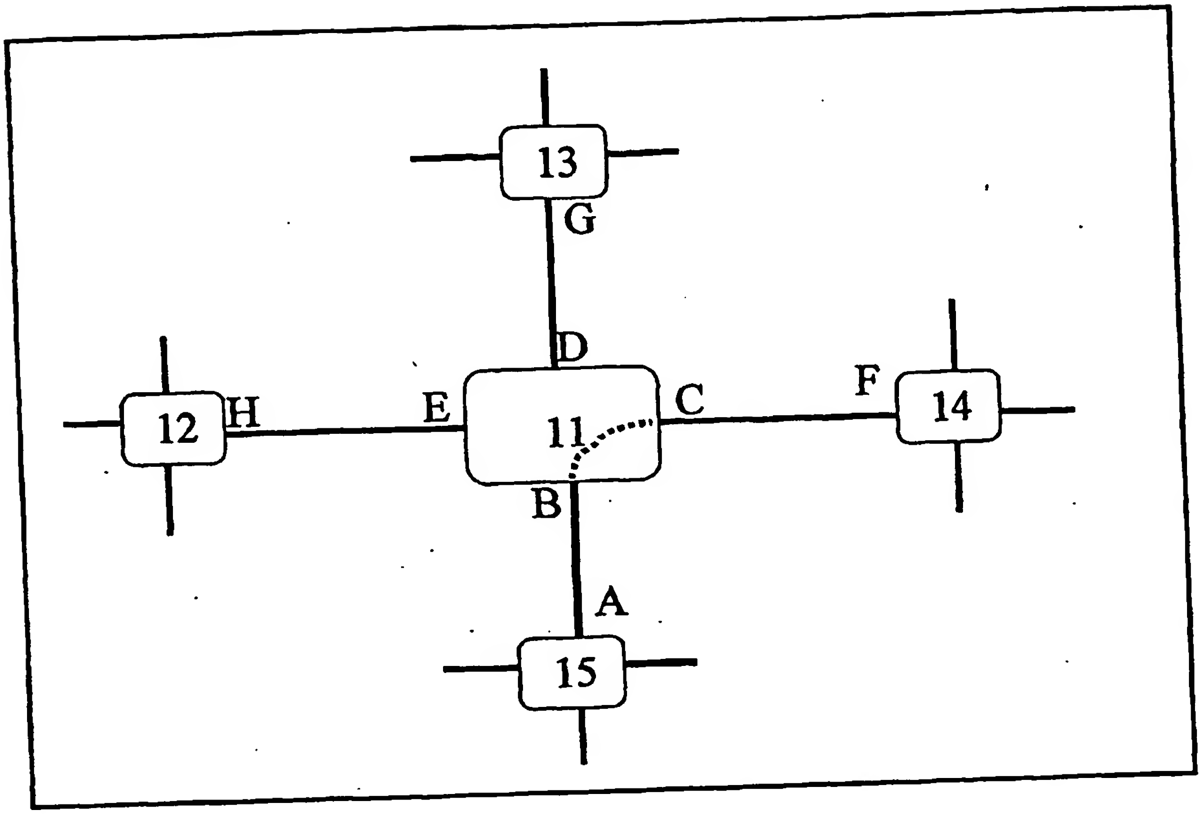

Figure 3

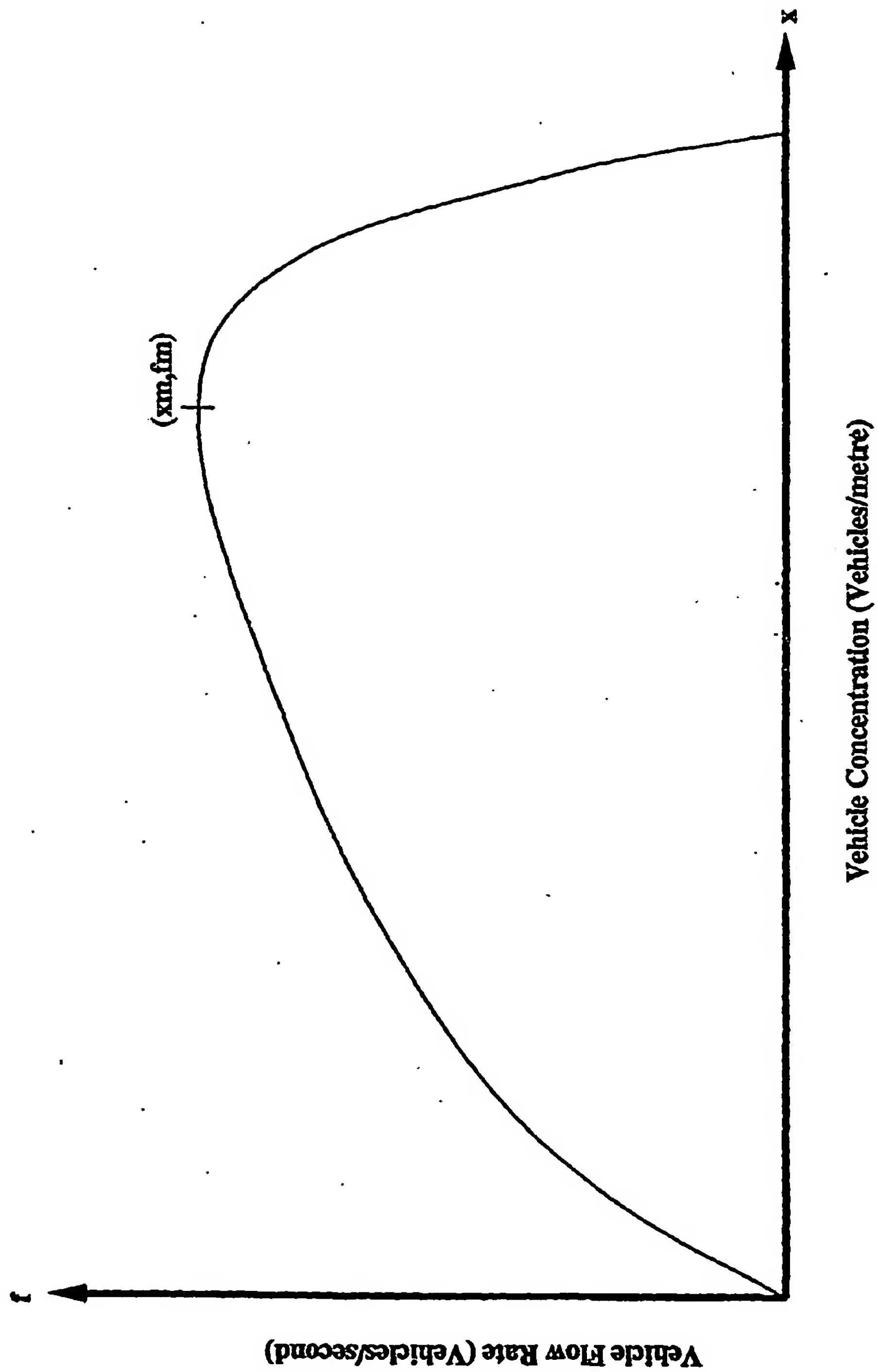
x
f
(xm,fm)
Vehicle Concentration (Vehicles/metre)
Vehicle Flow Rate (Vehicles/second)

Figure 4

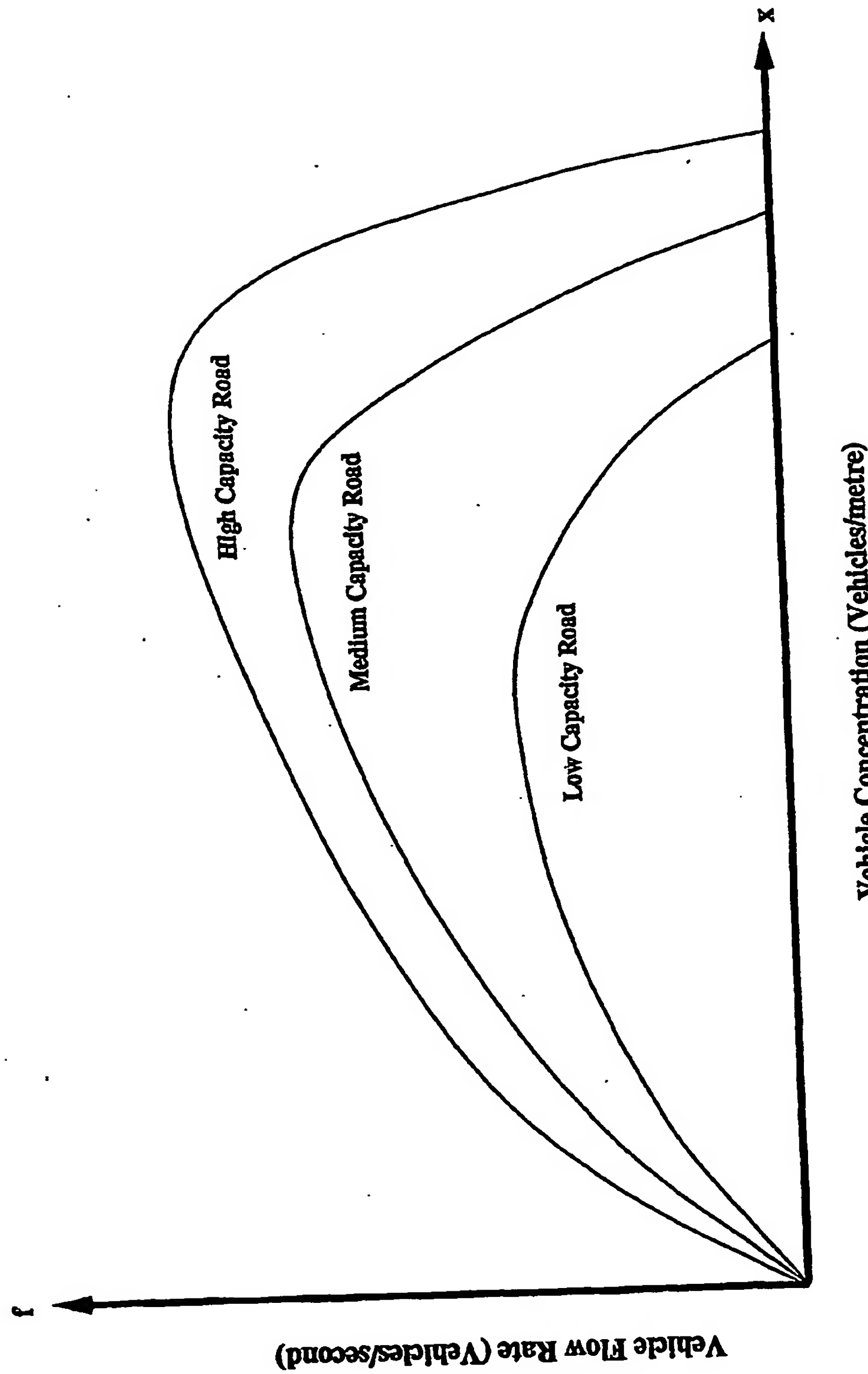
x
High Capacity Road
Medium Capacity Road
Low Capacity Road
Vehicle Concentration (Vehicles/metre)
Vehicle Flow Rate (Vehicles/second)

Figure 5

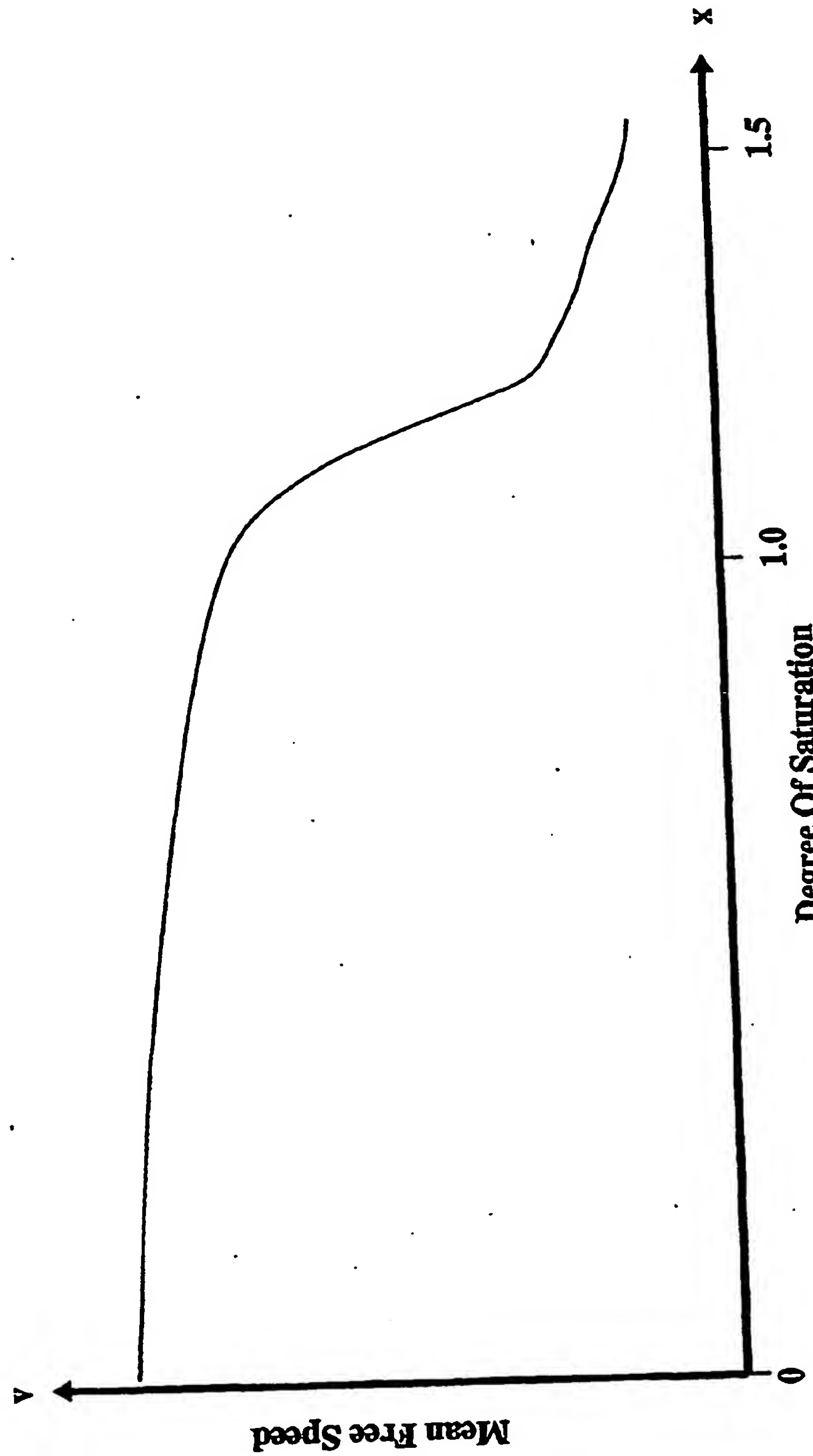

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/00758

A. CLASSIFICATION OF SUBJECT MATTER	
Int. Cl. 7: G08G 1/0968, H04Q 7/20	
According to International Patent Classification (IPC) or to both national classification and IPC	
B. FIELDS SEARCHED	
Minimum documentation searched (classification system followed by classification symbols) IPC: G08G, H04Q	
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT: traffic, motor+, vehicle?, car?, information, model+, statistic+.	

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 93/09511 A1 (MOTOROLA, INC.) 13 May 1993 Page 3 line 30-page 7 line 32	1-52
X	US 5610821 A (GAZIS et al) 11 March 1997 Whole document	1-52

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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Date of the actual completion of the international search	Date of mailing of the international search report
25 July 2001	30 July 2001
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer DEREK BARNES Telephone No : (02) 6283 2198

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/00758

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
WO	93/09511	EP	578788	US	6216086
US	5610821	JP	08-235496		

END OF ANNEX